

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

DET5088 – ANALOG ELECTRONICS 3
(DEE & DTE)

1 JUNE 2017
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 9 pages (8 pages with 5 questions and 1 page for appendix)
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 marks]

- (a) Sketch an ideal inverting summing amplifier where V_1 , V_2 and V_3 are three input signals. Also discuss its application of this circuitry.

(6 marks)

- (b) Explain the function of an instrumentation amplifier.

(2 marks)

- (c) Given the amplifier circuit in Figure 1(a) with $R_f = 3 \text{ k}\Omega$, $C = 1 \text{ nF}$ and Figure 1(b) shows its input waveform.

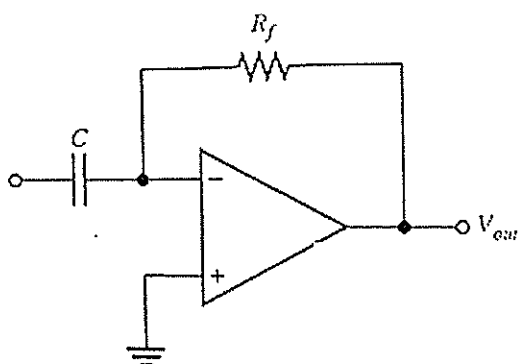


Figure 1(a)

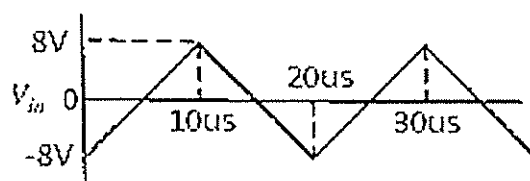


Figure 1(b)

- (i) Identify the type of op-amp amplifier in Figure 1(a).

(1 mark)

- (ii) Calculate the output voltage.

(4 marks)

- (iii) Draw the output voltage waveform and label it clearly

(3 marks)

Continued ...

- (d) Given the circuit in Figure 2 with the $R_1 = 2.2 \text{ k}\Omega$, $R_f = 65 \text{ k}\Omega$, $V_{IO} = 8 \text{ mV}$, $I_{IO} = 15 \text{ nA}$ and $I_B = 80 \text{ nA}$. Calculate the total output offset voltage due to input offset voltage, input offset current and bias current.

(4 marks)

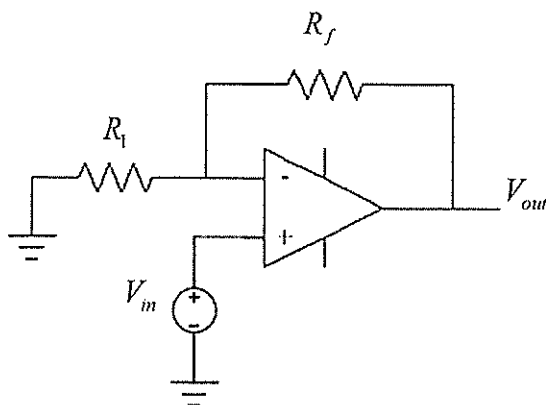


Figure 2

Continued ...

QUESTION 2 [20 marks]

(a) Briefly describe the types of the filters below and illustrate their frequency response.

(i) Low pass filter (2 marks)

(ii) High pass filter (2 marks)

(iii) Band-pass filter (2 marks)

(iv) Band-stop filter (2 marks)

(b) Explain the principle of Positive Feedback of a sinusoidal oscillator. (2 marks)

(c) Describe the construction of the Wien-Bridge Oscillator and sketch its schematic diagram. (5 marks)

(d) The voltage transfer function of a 2-pole filter is given as,

$$H(s) = \frac{\frac{40000}{s}}{\frac{10000}{s} + 100 + s}$$

(i) Determine the value of K (DC voltage gain), Q (quality factor) and ω_o (oscillation frequency). (4 marks)

(ii) Identify the type of the filter based on the transfer function. (1 mark)

Continued ...

QUESTION 3 [20 marks]

(a) Explain briefly the Input Offset Voltage, V_{IO} .

(2 marks)

(b) Referring to the Figure 3, bias current, I_B is a problem to the practical op-amp user because it flows in external impedances and produces voltages in inverting input, which result in the output offset voltage.

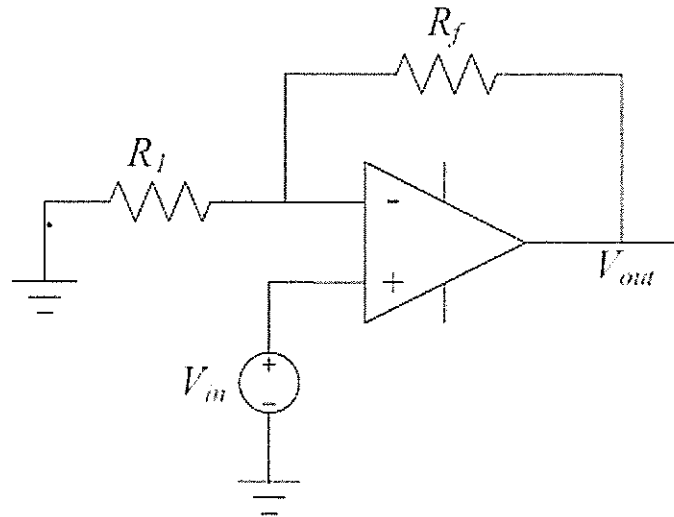


Figure 3

(i) Name another ONE cause which would also result in an error of the output voltage.

(1 mark)

(ii) Draw and explain the circuit that can be used to compensate the output offset voltage due to I_B .

(7 marks)

(c) Describe **THREE** solution to minimize the output error voltage due to the noise in the op-amp itself.

(6 marks)

Continued ...

- (d) The slew rate for a 741 series op-amp in Figure 4 is 0.8 V/us. Determine the maximum operating frequency supported by the slew rate by referring to the Table 1 below.

(4 marks)

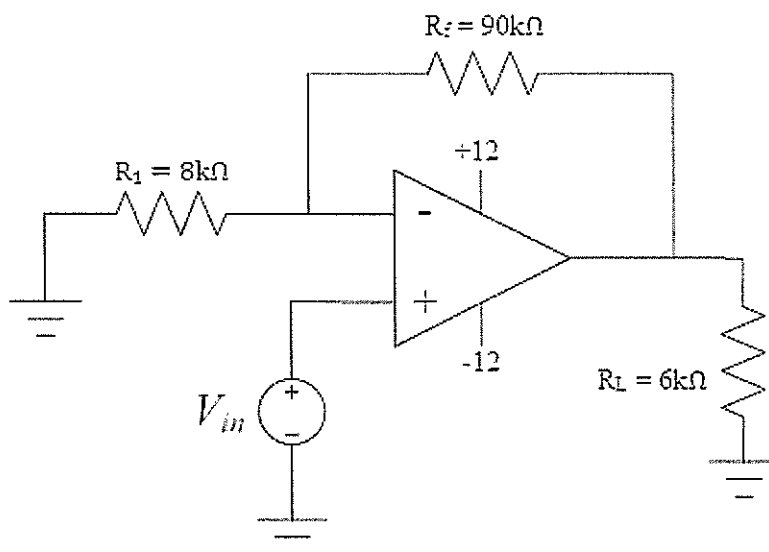


Figure 4

Load Resistance	Maximum Positive Output in Volts	Maximum Negative Output in Volts
Greater than 10k ohm	$V_{CC} - 1$	$V_{EE} + 1$
2 to 10k Ohm	$V_{CC} - 2$	$V_{EE} + 2$

Table 1

Continued ...

QUESTION 4 [20 marks]

- (a) Explain a basic unregulated power supply with aid of the diagram circuit. (6 marks)
- (b) Describe the basic operation of the series feedback regulator. (10 marks)
- (c) Given a series feedback regulator in Figure 5 with $R_A = 45\text{ k}\Omega$, $R_B = 50\text{ k}\Omega$ and Zener voltage, $V_Z = 4.7\text{ V}$.

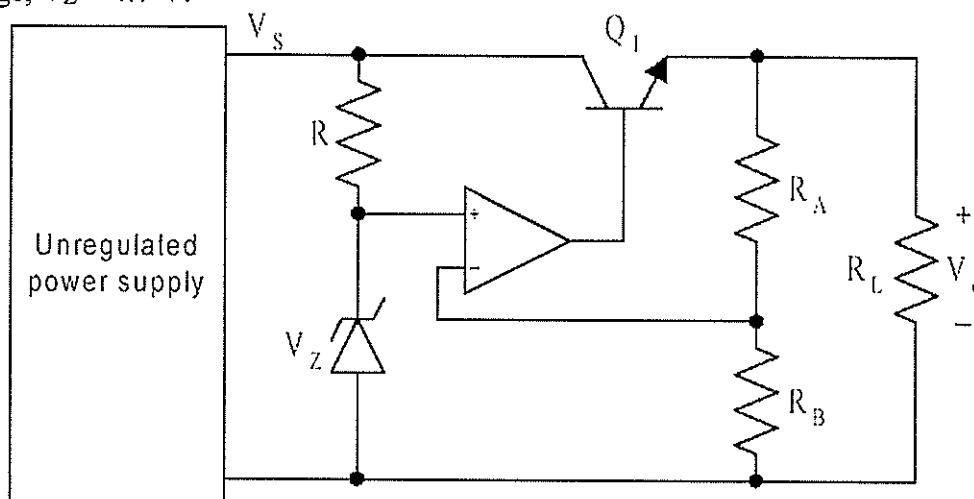


Figure 5

- (i) Identify the function of the Zener diode in the series feedback regulator in Figure 5. (1 mark)
- (ii) Determine the output voltage. (3 marks)

Continued ...

QUESTION 5 [20 marks]

(a) Briefly explain the function of a comparator and give one example of its application. (3 marks)

(b) Describe the effect of the noise on the comparator output with aid of the waveform diagram. (5 marks)

(c) The main drawback of the Schmitt Trigger circuit shown in Figure 6 is symmetrical of V_{UTP} and V_{LTP} which have same magnitude of the thresholds with different polarity.

Modify and draw a Schmitt Trigger circuit which will provide unequal magnitude of the threshold based on Figure 6. Justify with the formula. (5 marks)

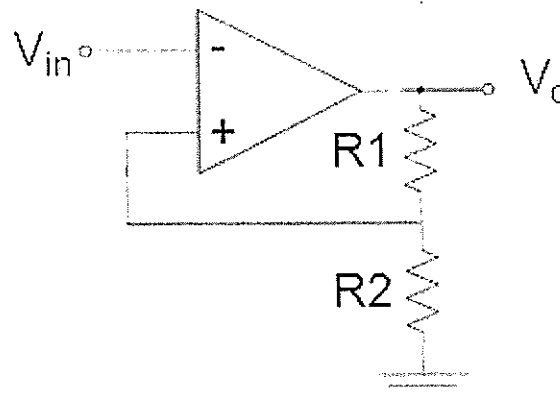


Figure 6

Continued ...

- (d) Referring to the Schmitt Trigger in Figure 7, given that $R_f = 65 \text{ k}\Omega$ and $R_1 = 45 \text{ k}\Omega$ to produce the output voltage of $\pm 10 \text{ V}$.

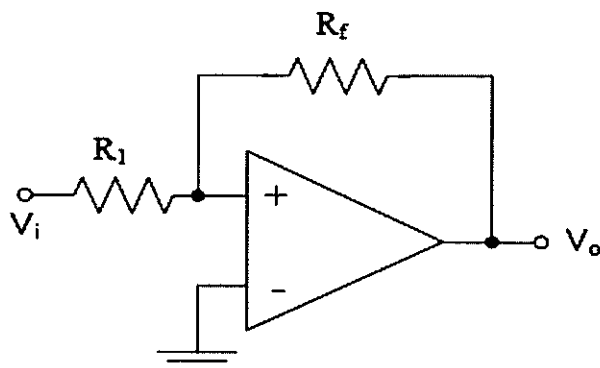


Figure 7

- (i) Identify the type of the Schmitt trigger. (1 mark)
- (ii) Calculate the V_{UTP} and V_{LTP} . (4 marks)
- (iii) Determine the hysteresis voltage, V_H . (2 marks)

End of Page.

APPENDIX

Biquadratic voltage transfer function

Filter type	k_0, k_1, k_2	Voltage transfer function
Low-pass	1, 0, 0	$H_{LP}(s) = \frac{K\omega_o^2}{s^2 + (\omega_o/Q)s + \omega_o^2}$
High-pass	0, 0, 1	$H_{HP}(s) = \frac{Ks^2}{s^2 + (\omega_o/Q)s + \omega_o^2}$
Band-pass	0, 1, 0	$H_{BP}(s) = \frac{K(\omega_o/Q)s}{s^2 + (\omega_o/Q)s + \omega_o^2}$
Band-reject	1, 0, 1	$H_{BR}(s) = \frac{K(s^2 + \omega_o^2)}{s^2 + (\omega_o/Q)s + \omega_o^2}$
All-pass	1, -1, 1	$H_{AP}(s) = K \frac{s^2 - (\omega_o/Q)s + \omega_o^2}{s^2 + (\omega_o/Q)s + \omega_o^2}$